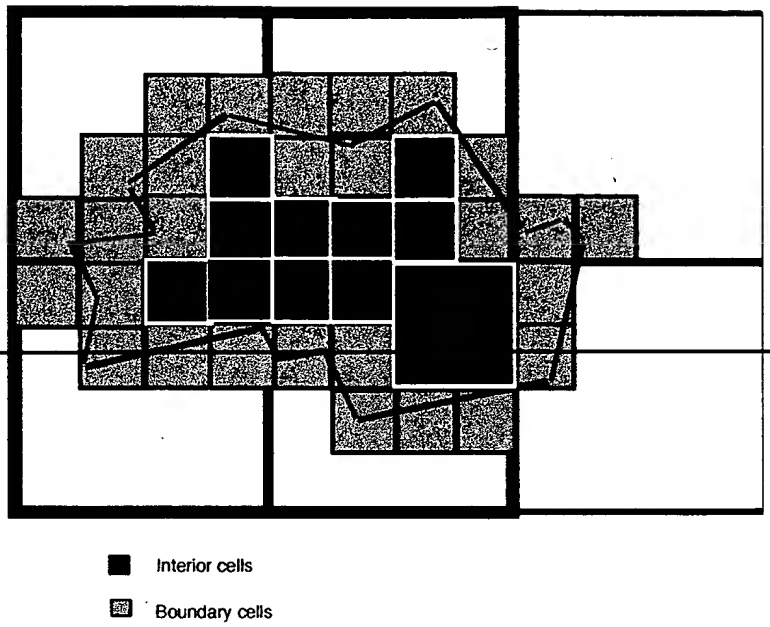


Fig. 1

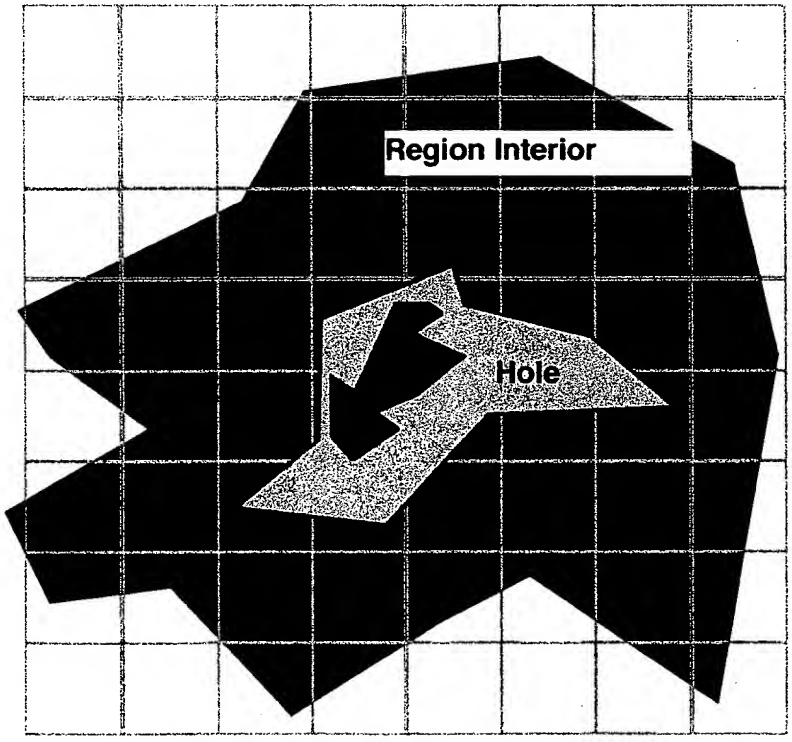


Fig. 2

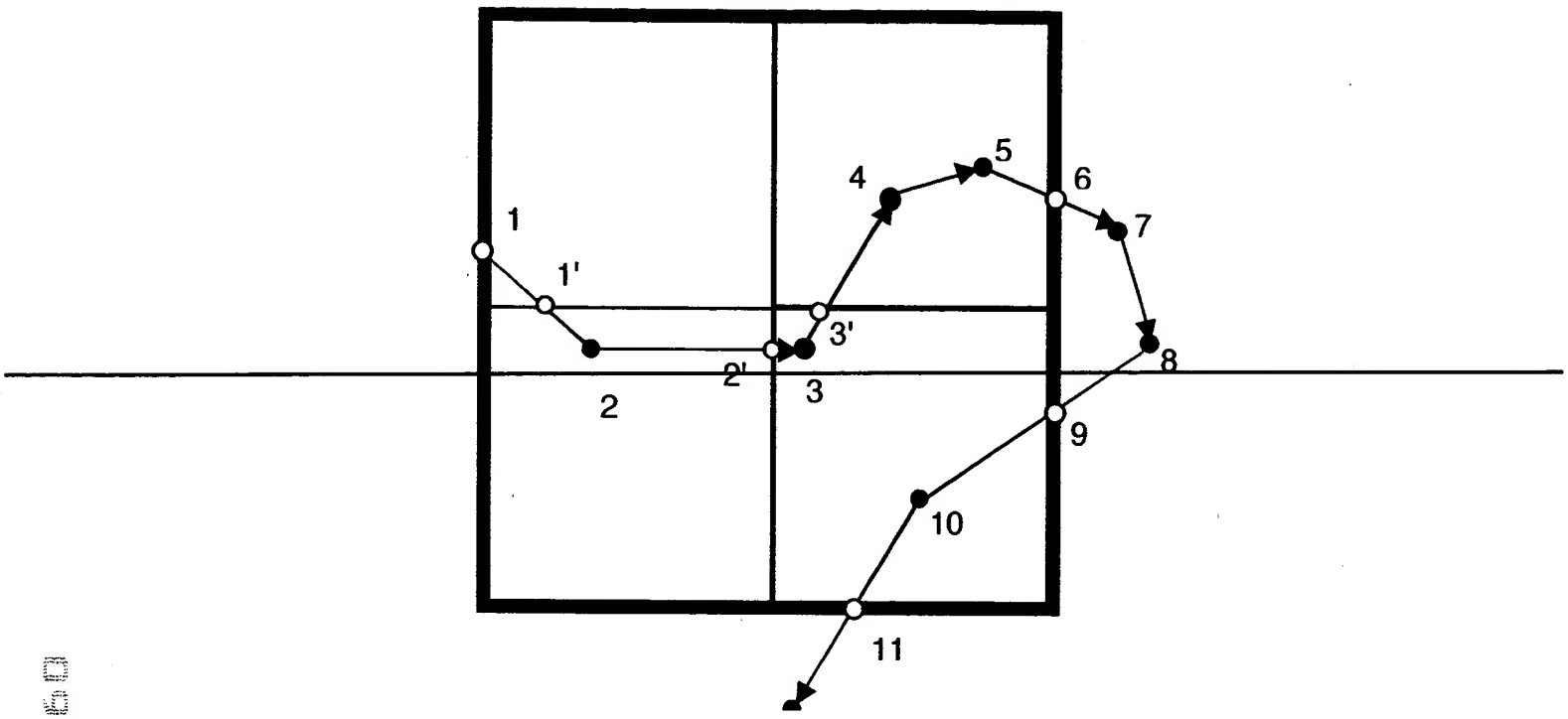

1
1'
2
2'
3
3'
4
5
6
7
8
9
10
11

Fig. 3.

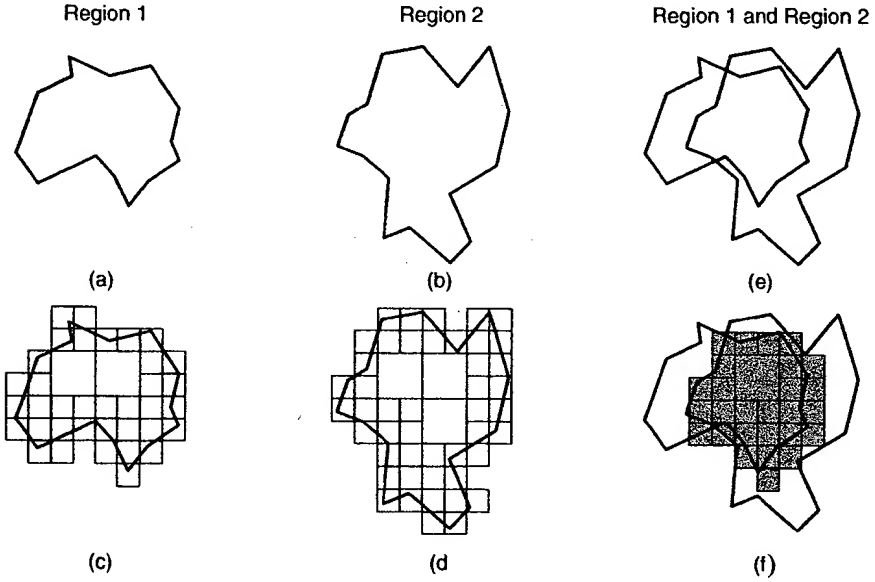

Region 1
Region 2
Region 1 and Region 2
(a)
(b)
(e)
(c)
(d
(f)

Fig. 4

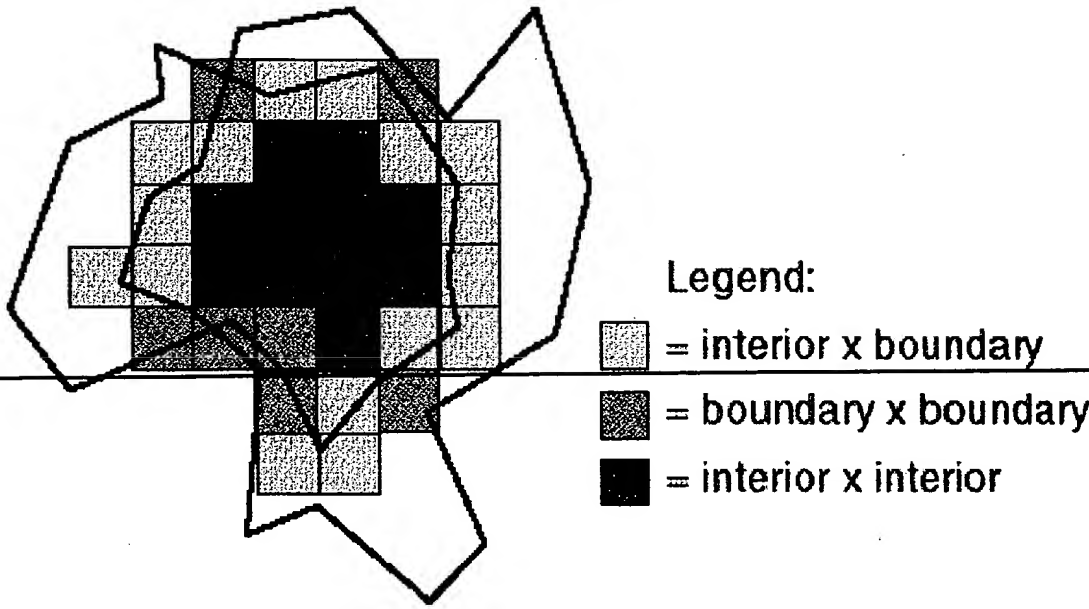


Fig. 5

Document - 0 9 4 5 9 2 0 2

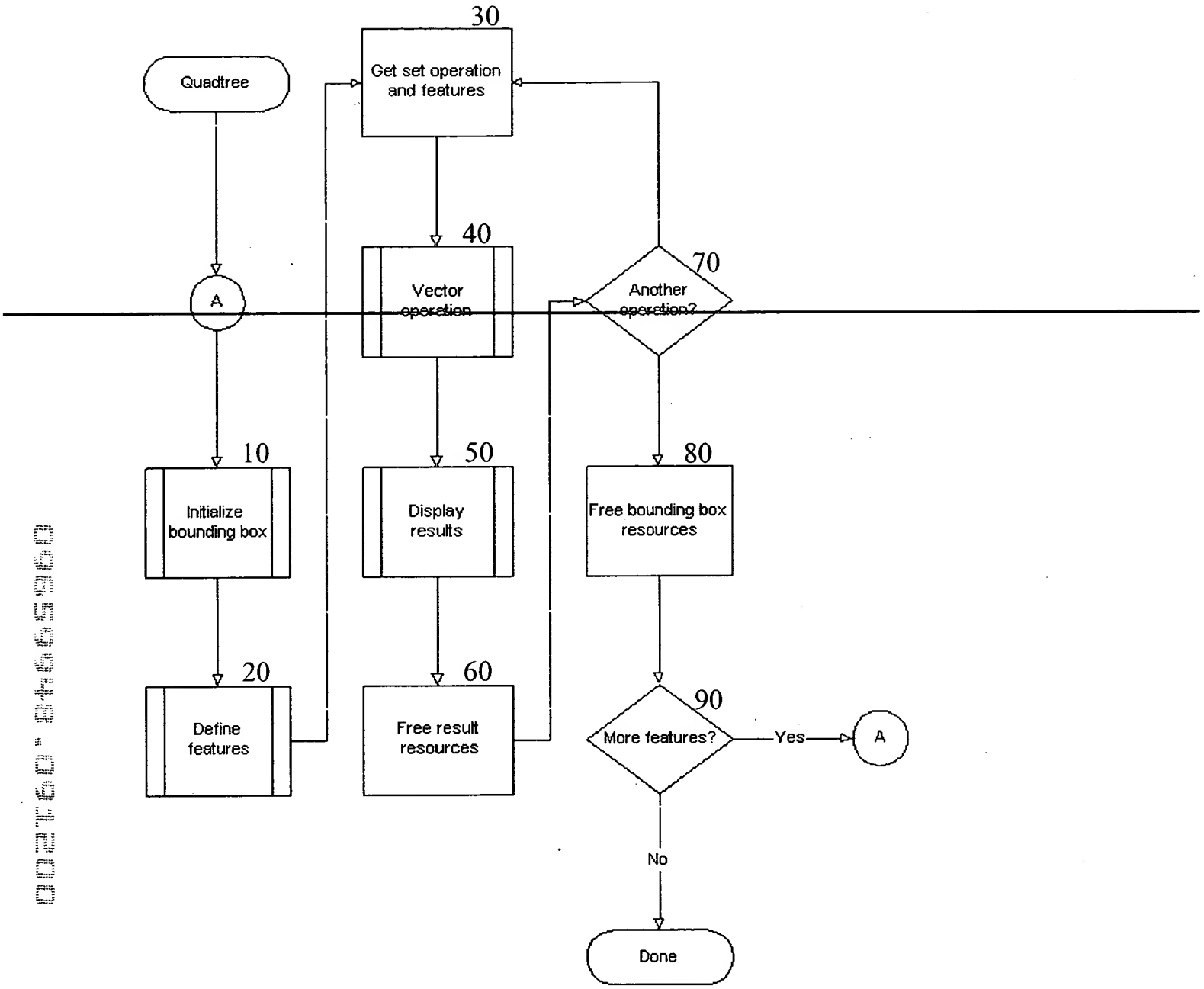

30
Quadtree
Get set operation and features
40
A
Vector operation
70
Another operation?
10
Initialize bounding box
50
Display results
80
Free bounding box resources
20
Define features
60
Free result resources
90
More features?
Yes
A
No
Done

Fig. 6

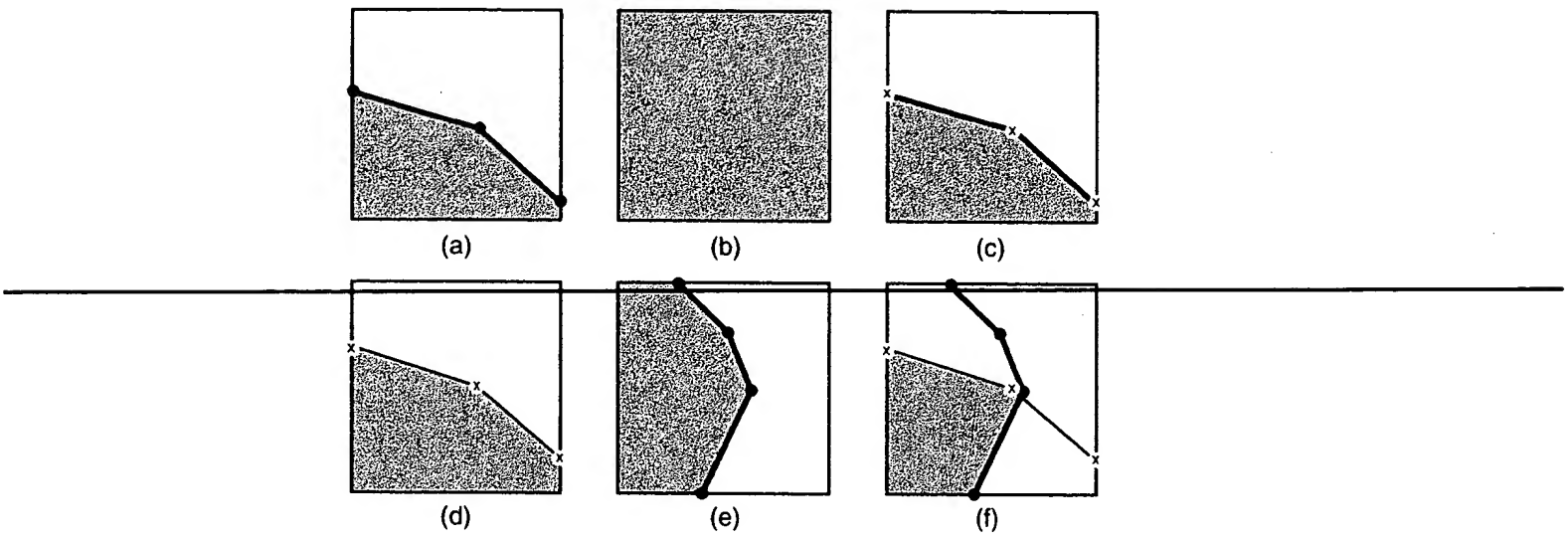
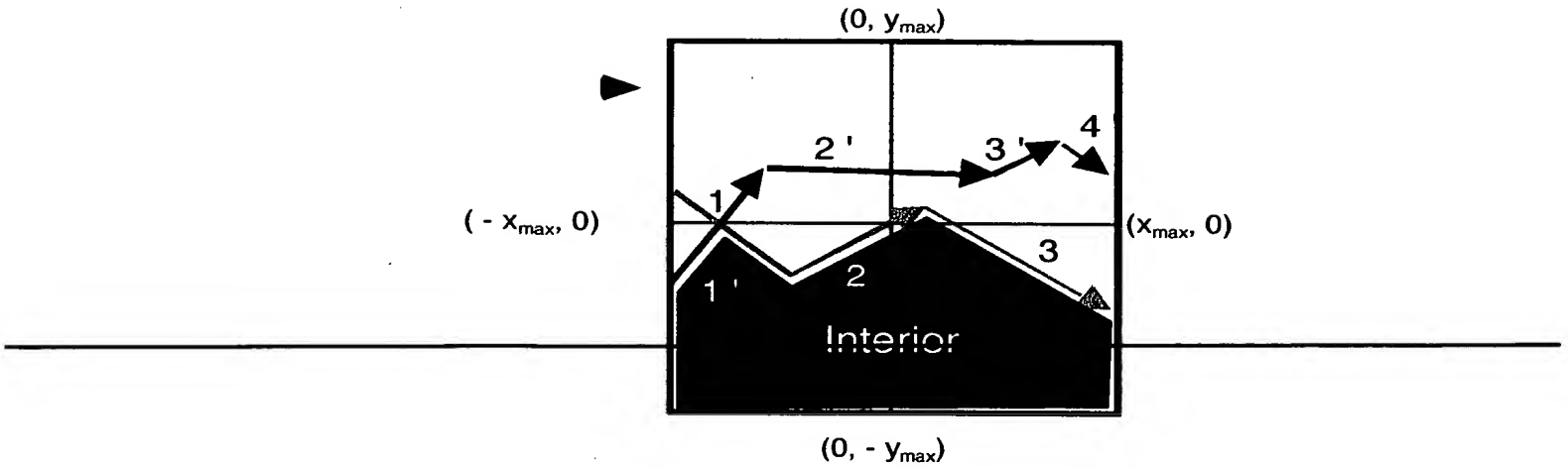
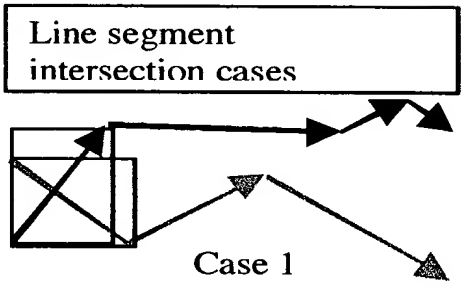


Fig. 7

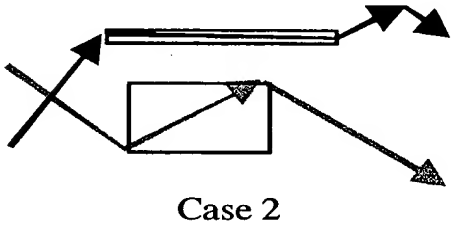
0656568 - 060200



The two bounding boxes associated with the first two tuple-pairs from both features intersects as shown to the right



The bounding boxes associated with the second set of tuple-pairs do not intersect



In the case to the right, two black line segments must be evaluated for intersection with a single red line segment.

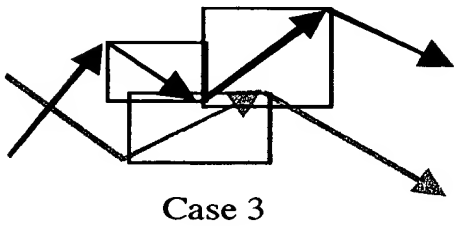


Fig. 8.

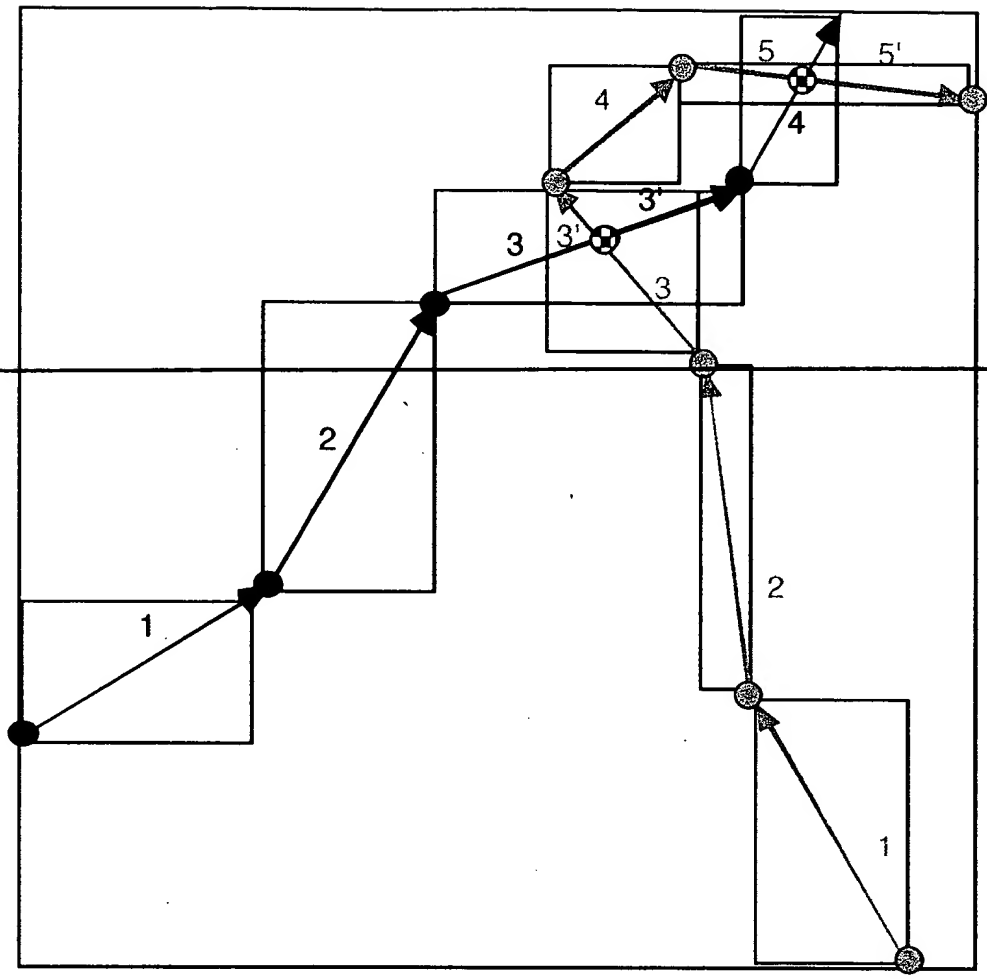


Fig. 9.

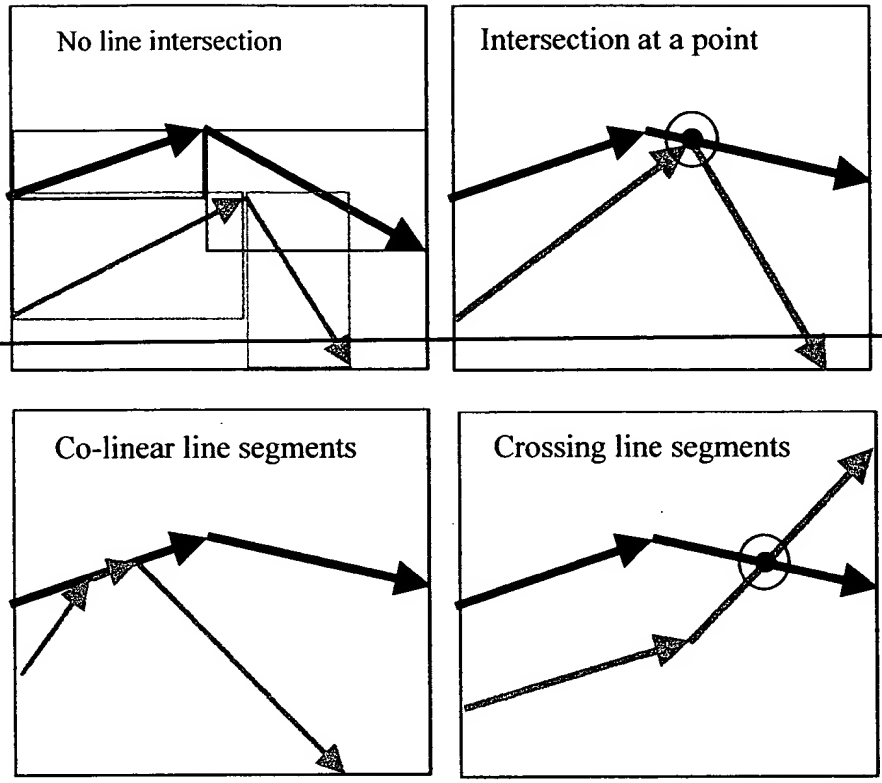

No line intersection
Intersection at a point
Co-linear line segments
Crossing line segments

Fig. 10

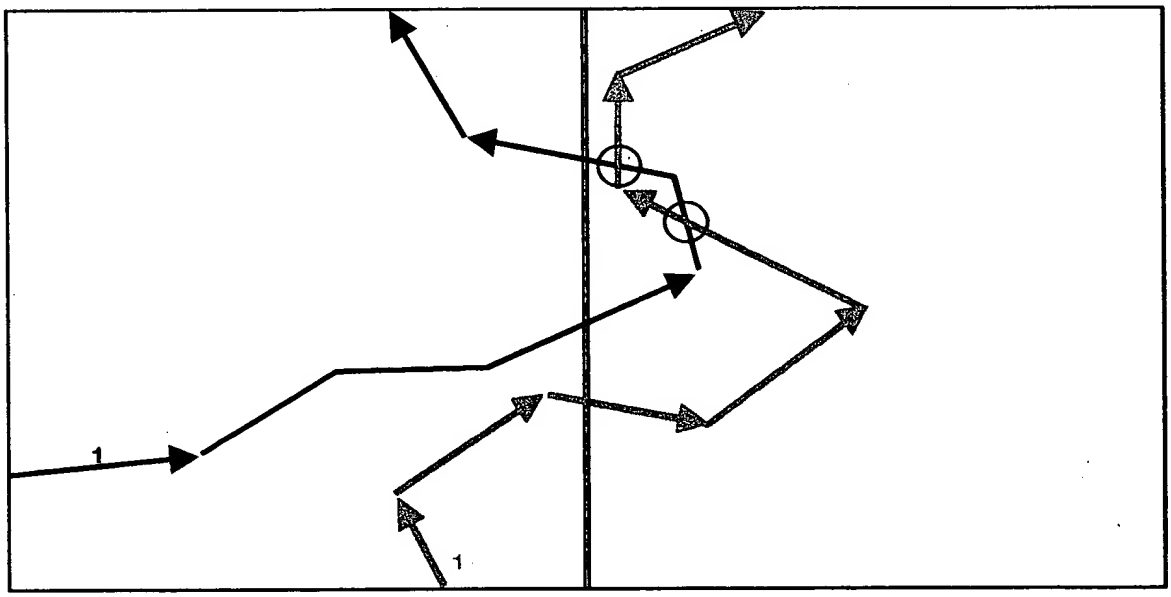

1
1

Fig. 11

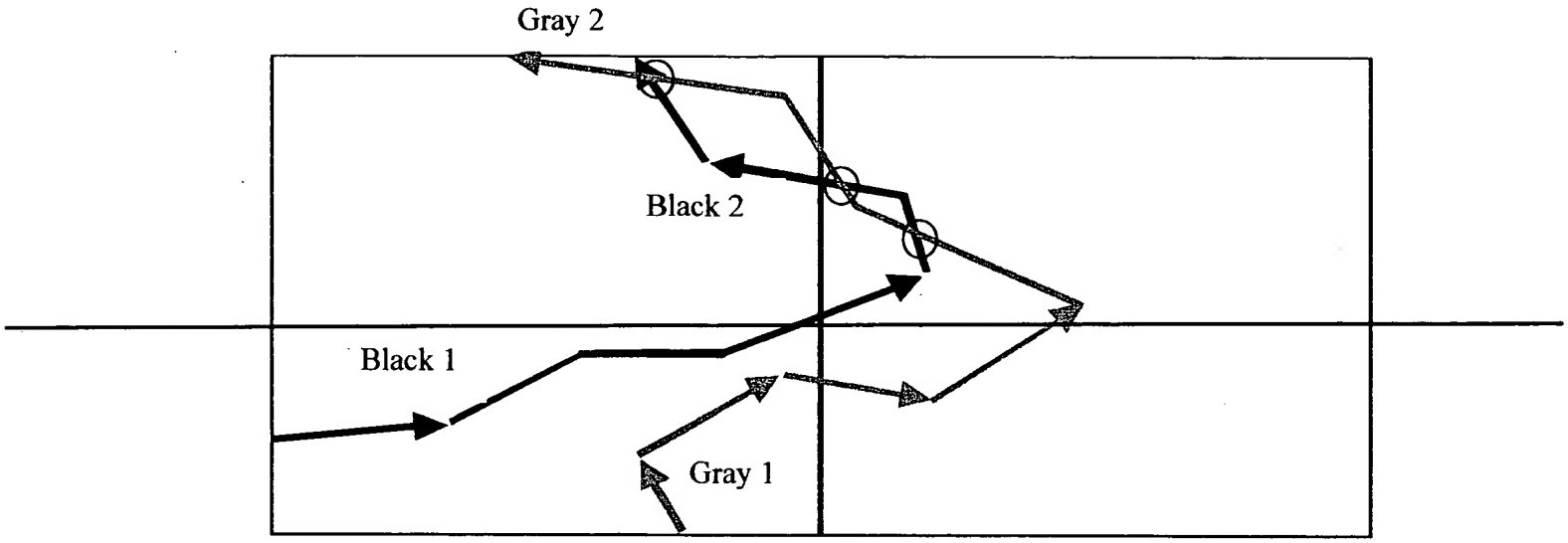


Fig. 12

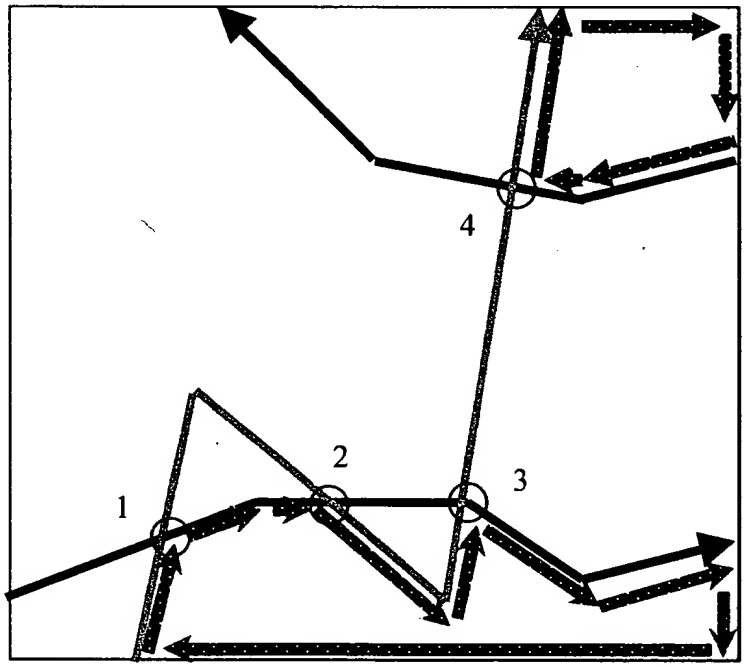


Fig. 13

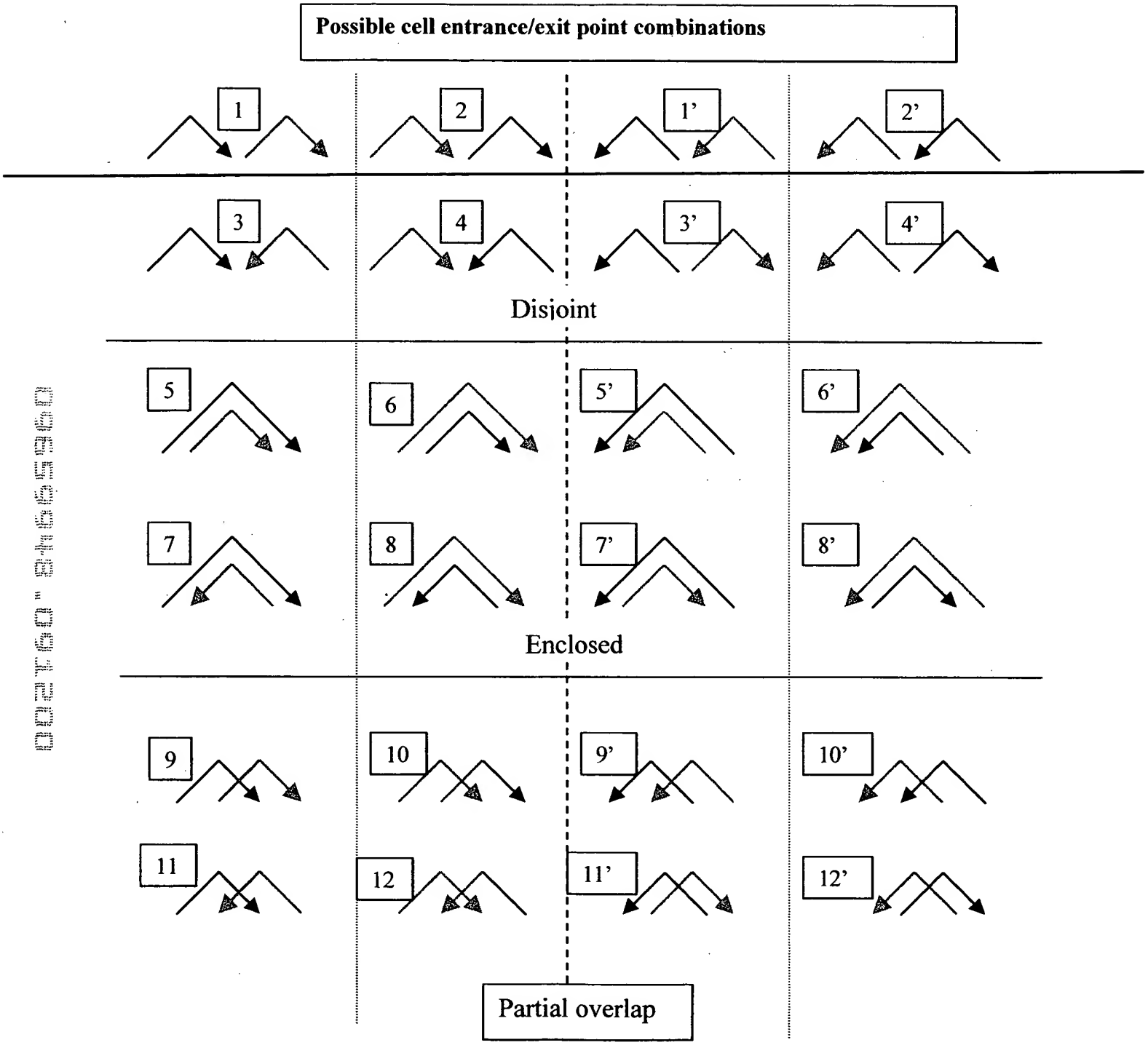

Possible cell entrance/exit point combinations
1
2
1'
2'
3
4
3'
4'
Disjoint
5
6
5'
6'
7
8
7'
8'
Enclosed
9
10
9'
10'
11
12
11'
12'
Partial overlap

Fig. 14

Entry/Exit Relationship	Class	Begin point for first cycle (inside is "to the right") Intersection	Begin point for first cycle (inside is "to the right") Union	Begin point for first cycle (inside "to the left") Intersection	Begin point for first cycle (inside "to the left") Union
$G_E G_X B_E B_X$	I	First intersection point of black or gray feature (Null if no intersect points)	Pseudo points (B_E and G_E)	Pseudo points (B_E and G_E)	First intersection point of black or gray feature (Full cell if no intersect points)
$G_E B_X B_E G_X$	II	Pseudo points (B_E and G_E)	First intersection point of black or gray feature (Full cell if no intersect points)	First intersection point of black or gray feature (Null if no intersect points)	Pseudo points (B_E and G_E)
$G_E B_E B_X G_X$	III	Pseudo point B_E	Pseudo point G_E	Pseudo point G_E	Pseudo point B_E
$G_E B_E G_X B_X$	VI	Pseudo point B_E	Pseudo point G_E	Pseudo point G_E	Pseudo point B_E
$G_E G_X B_X B_E$	IV	Pseudo point G_E	Pseudo point B_E	Pseudo point B_E	Pseudo point G_E
$G_E B_X G_X B_E$	V	Pseudo point G_E	Pseudo point B_E	Pseudo point B_E	Pseudo point G_E

Application of table:
Follow specified boundary entrance feature, accumulating intersection and/or union cycles until all polyline intersection point tuples in the cell have been exhausted.
Cycles alternate systematically along the specified entrance feature between contributions to intersection and union.
Cycles are completed when they close on themselves. The implicit boundary-closing segments of a boundary-closing cycle are not actually represented in the generated product.

Comments:
As is apparent from the above formulation, intersection and union are effectively dual operations. The set operation generation procedure is similar regardless of the ordering convention of the polygon tuples (clockwise or counter-clockwise oriented), reflected in the symmetry observed within the above table.
Note that the classes are grouped into pairs. Classes I and II involve *inverse* operations; Classes III and VI employ identical generation operations, as do Classes IV and V.

Fig. 15

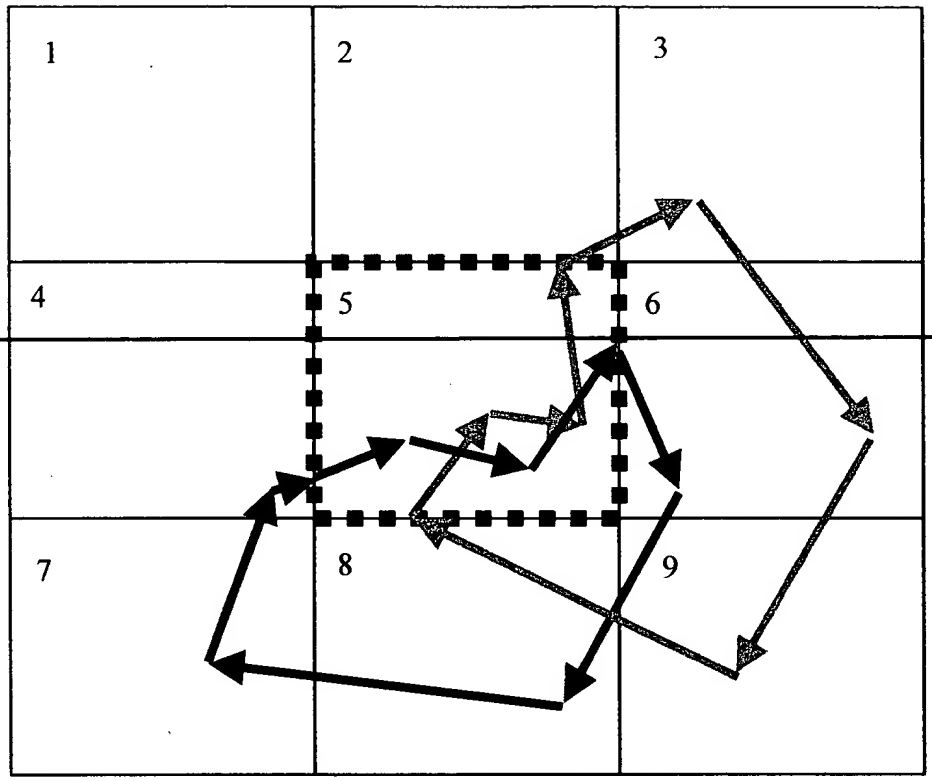


Fig. 16

09695424 - 050200

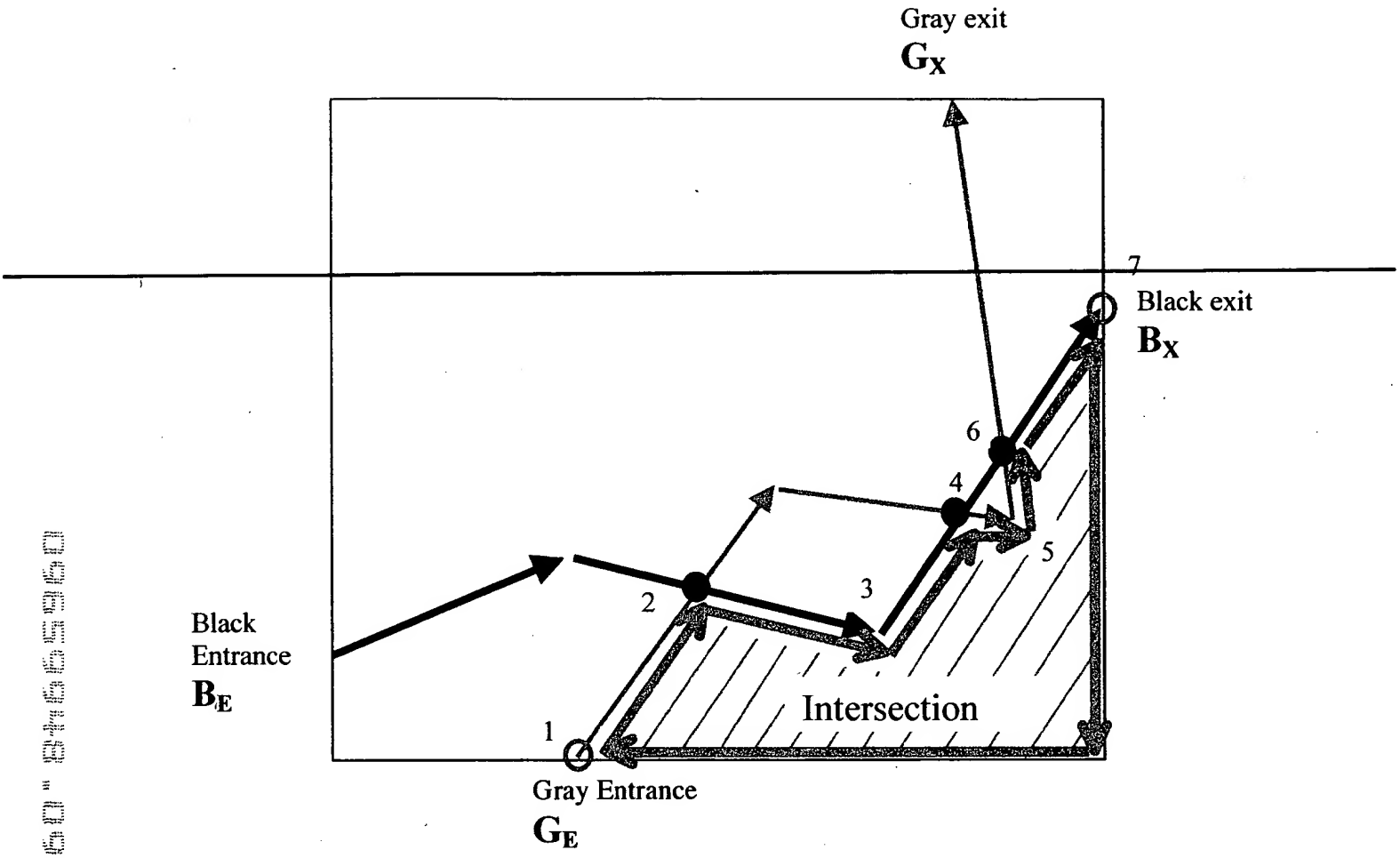

Gray exit
G_X
7
Black exit
B_X
6
4
5
3
2
Black
Entrance
B_E
Intersection
1
Gray Entrance
G_E

Fig. 17

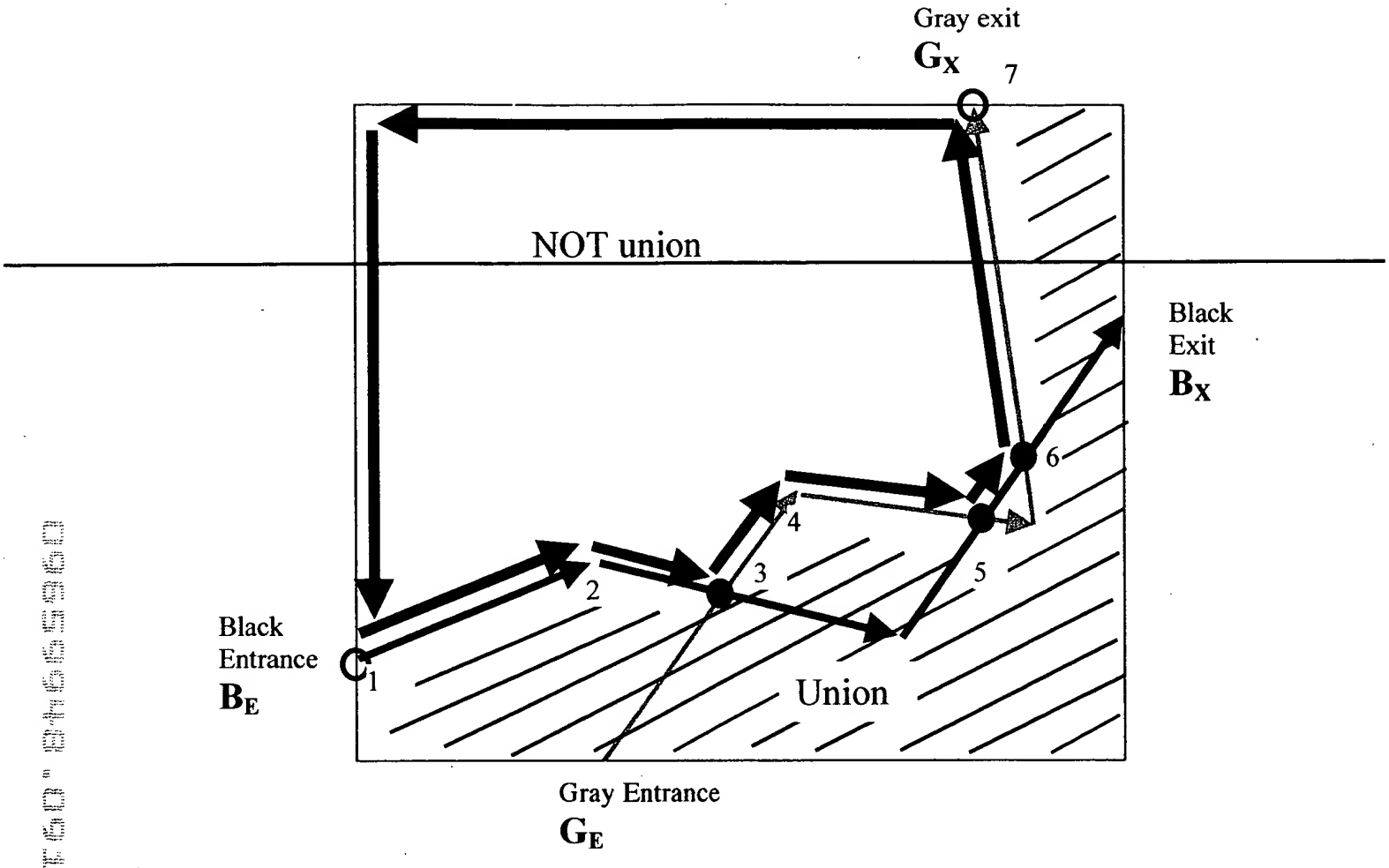

Gray exit
G_X
7
NOT union
Black
Exit
B_X
6
4
3
5
2
Black
Entrance
B_E
1
Union
Gray Entrance
G_E

Fig. 18

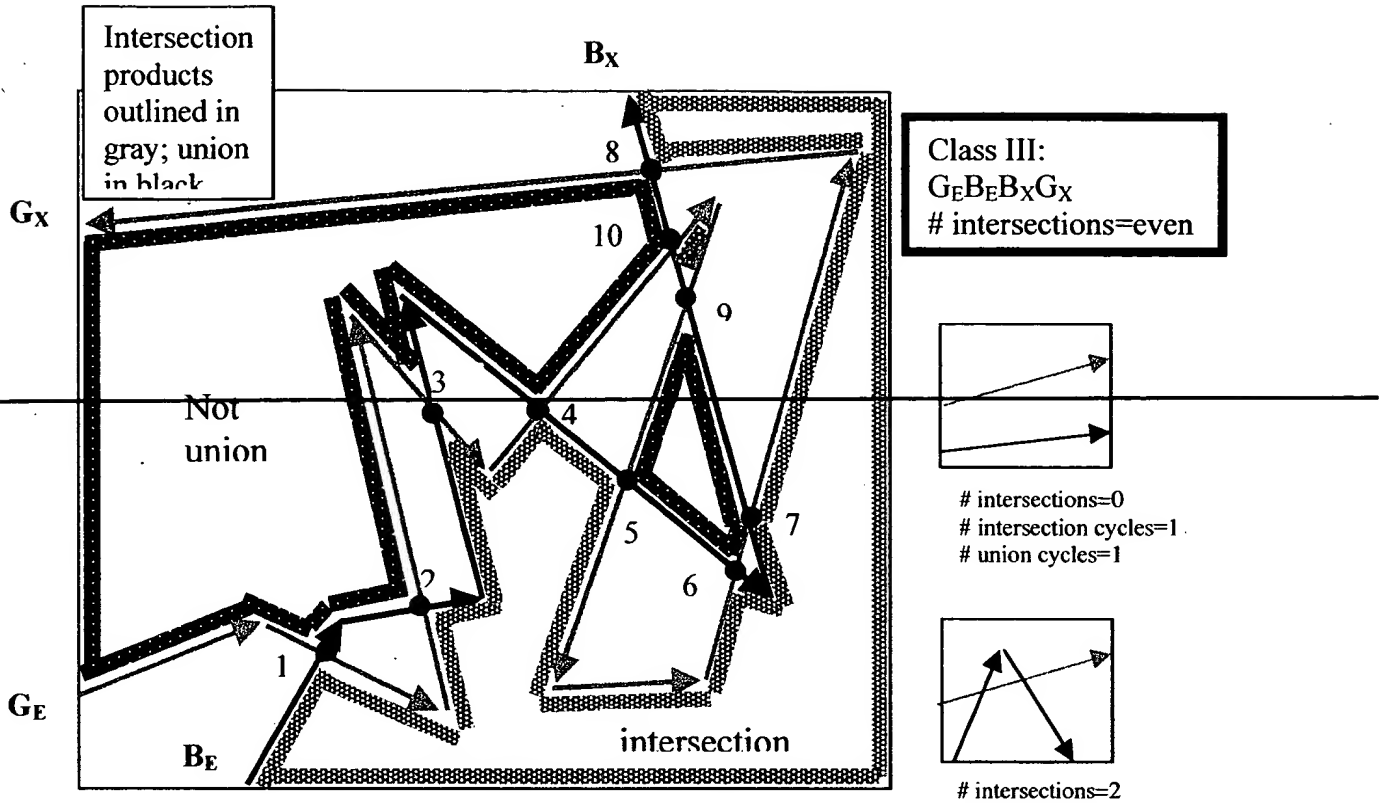

Intersection products outlined in gray; union in black
B_X
G_X
G_E
B_E
Not union
intersection
1
2
3
4
5
6
7
8
9
10
Class III:
$G_E B_E B_X G_X$
intersections=even
intersections=0
intersection cycles=1
union cycles=1
intersections=2
intersection cycles=1
union cycles=1

Fig. 19

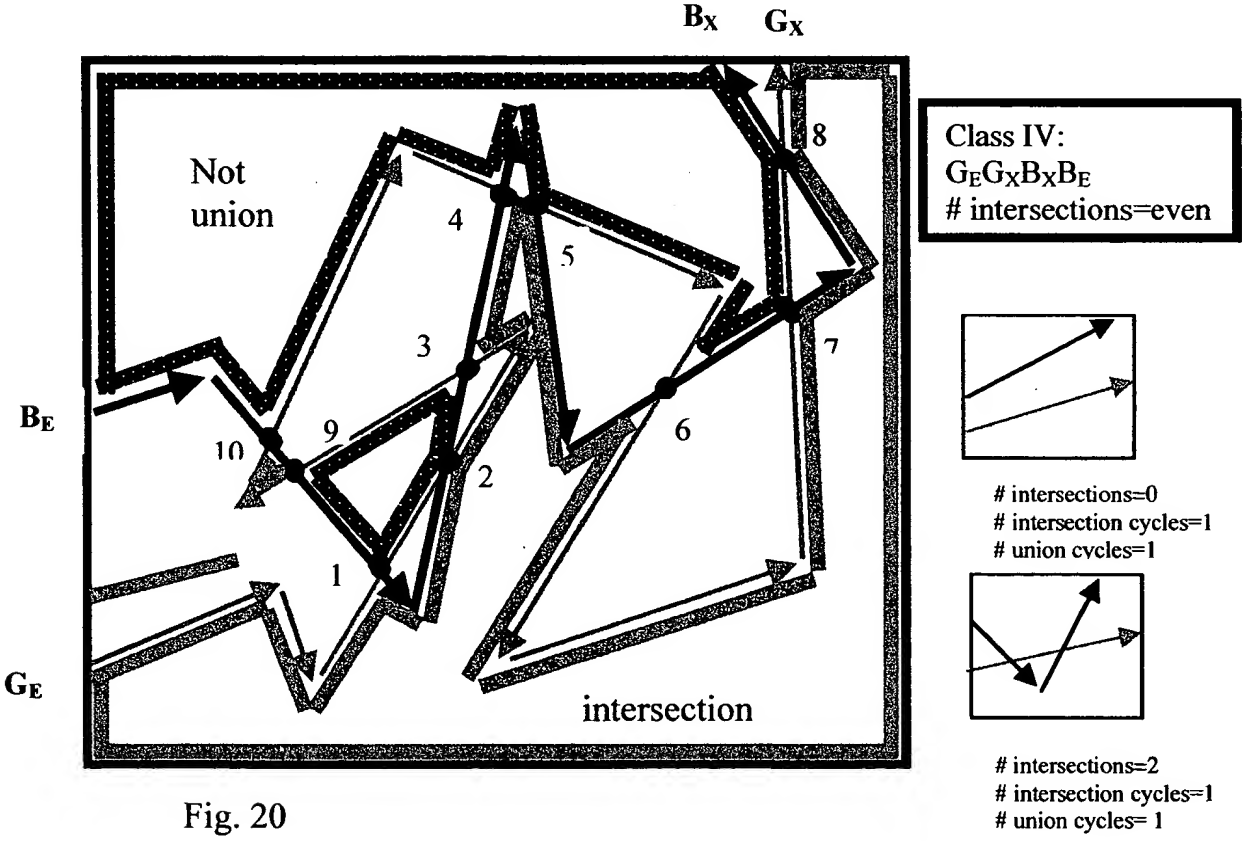

B_X
G_X
B_E
G_E
Not union
intersection
1
2
3
4
5
6
7
8
9
10
Class IV:
$G_E G_X B_X B_E$
intersections=even
intersections=0
intersection cycles=1
union cycles=1
intersections=2
intersection cycles=1
union cycles= 1

Fig. 20

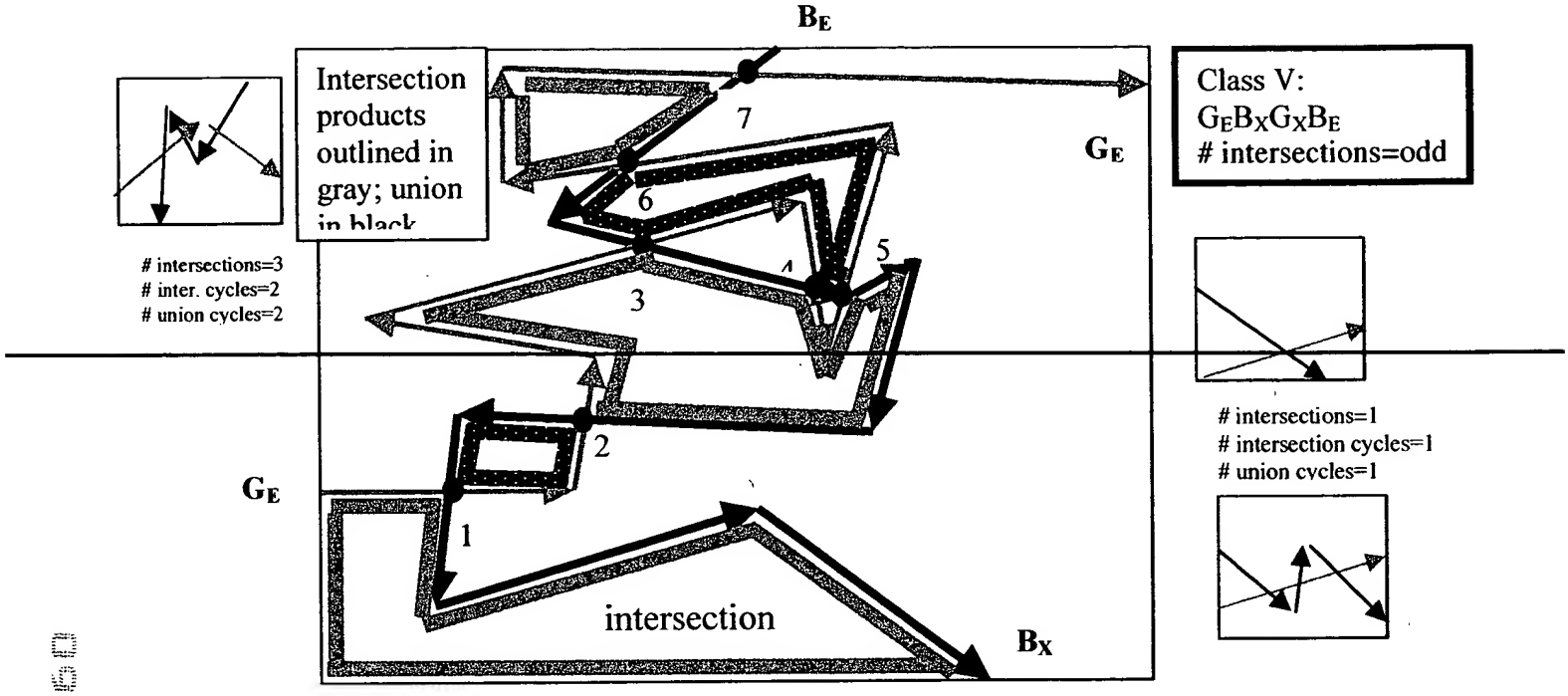

B_E
Intersection products outlined in gray; union in black
Class V:
$G_EB_XG_XB_E$
intersections=odd
G_E
7
6
5
3
2
1
G_E
intersection
B_X
intersections=3
inter. cycles=2
union cycles=2
intersections=1
intersection cycles=1
union cycles=1

Fig. 21

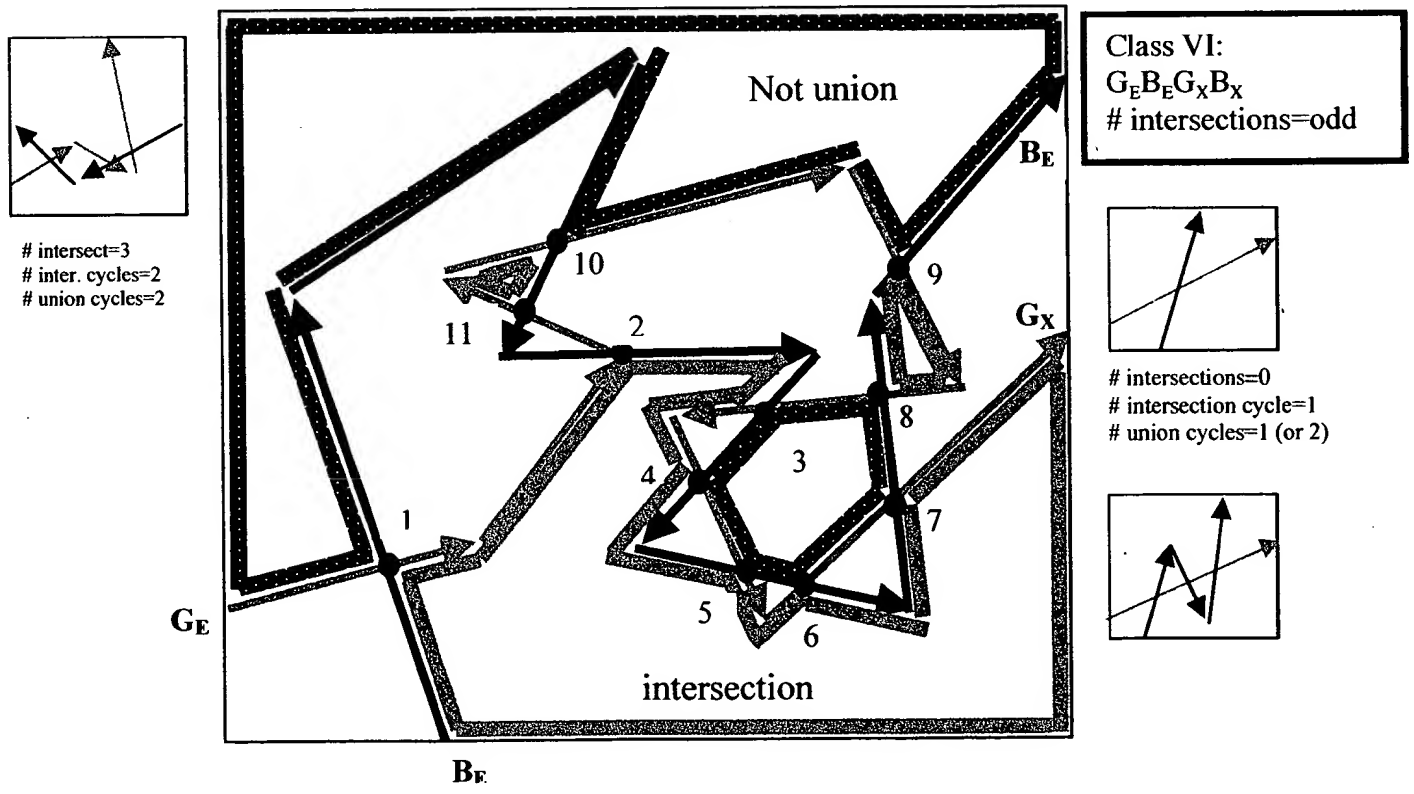

Not union
Class VI:
$G_EB_EG_XB_X$
intersections=odd
B_E
G_X
10
9
11
2
8
3
4
7
1
5
6
G_E
intersection
B_E
intersect=3
inter. cycles=2
union cycles=2
intersections=0
intersection cycle=1
union cycles=1 (or 2)

Fig. 22

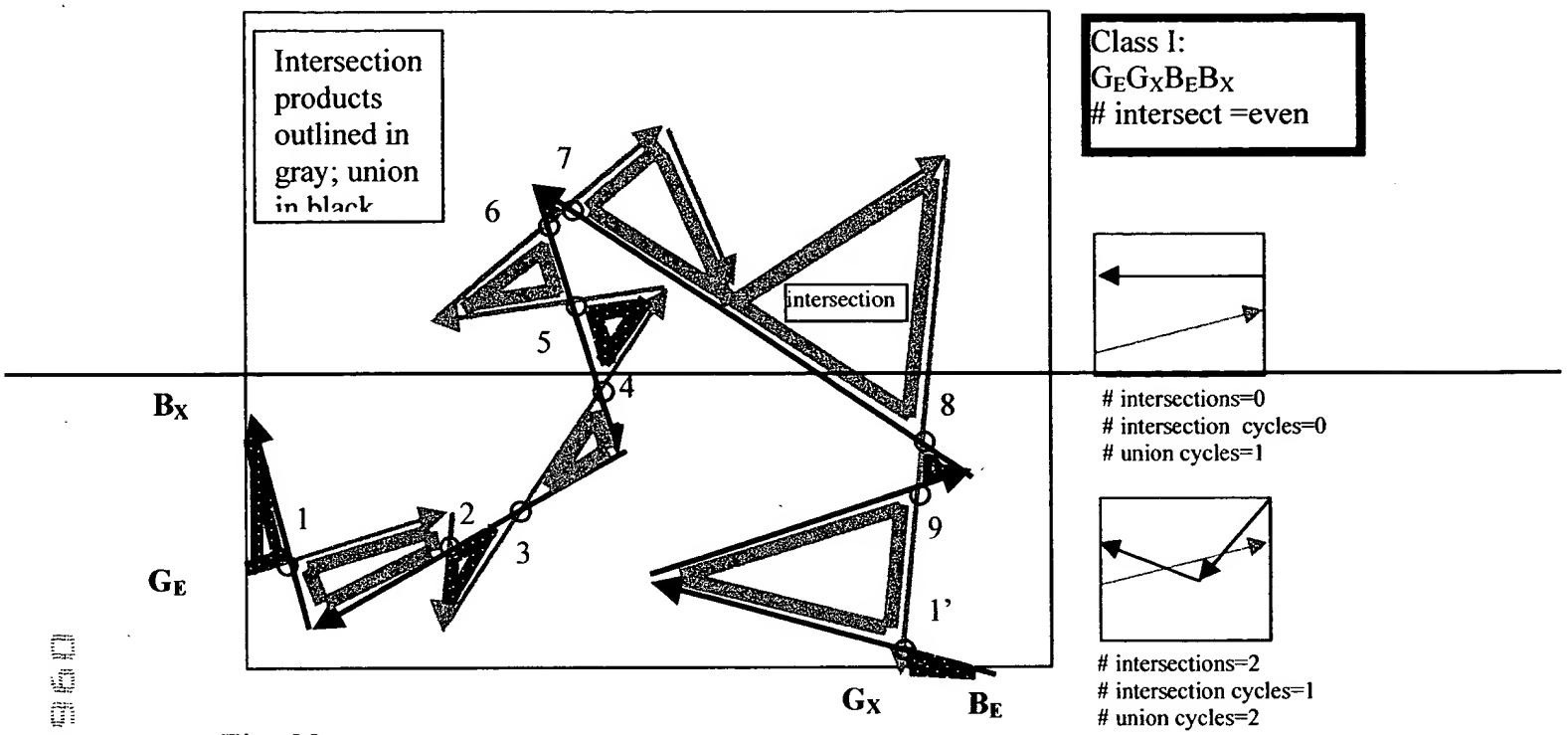

Intersection products outlined in gray; union in black
Class I:
$G_E G_X B_E B_X$
intersect =even
intersection
B_X
G_E
G_X
B_E
1
2
3
4
5
6
7
8
9
1'
intersections=0
intersection cycles=0
union cycles=1
intersections=2
intersection cycles=1
union cycles=2

Fig. 23

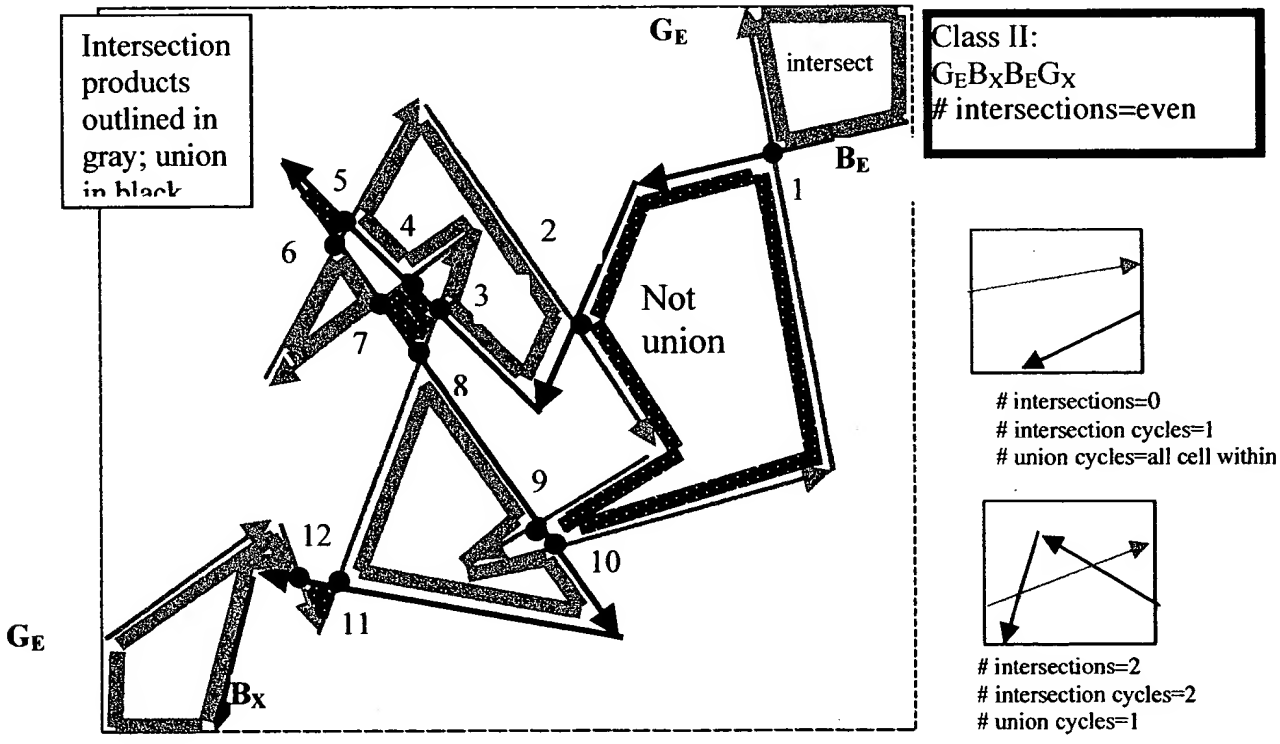

Intersection products outlined in gray; union in black
G_E
intersect
B_E
Class II:
$G_E B_X B_E G_X$
intersections=even
Not union
G_E
B_X
1
2
3
4
5
6
7
8
9
10
11
12
intersections=0
intersection cycles=1
union cycles=all cell within
intersections=2
intersection cycles=2
union cycles=1

Fig. 24.

Class IV:
$G_E G_X B_X B_E$

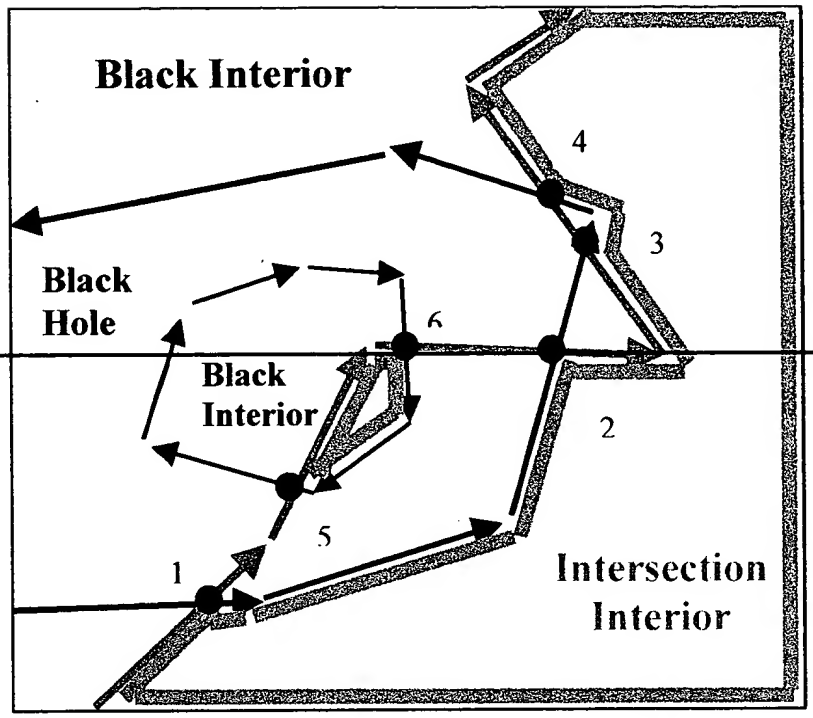


Fig. 25

Class I:
$G_E G_X B_E B_X$

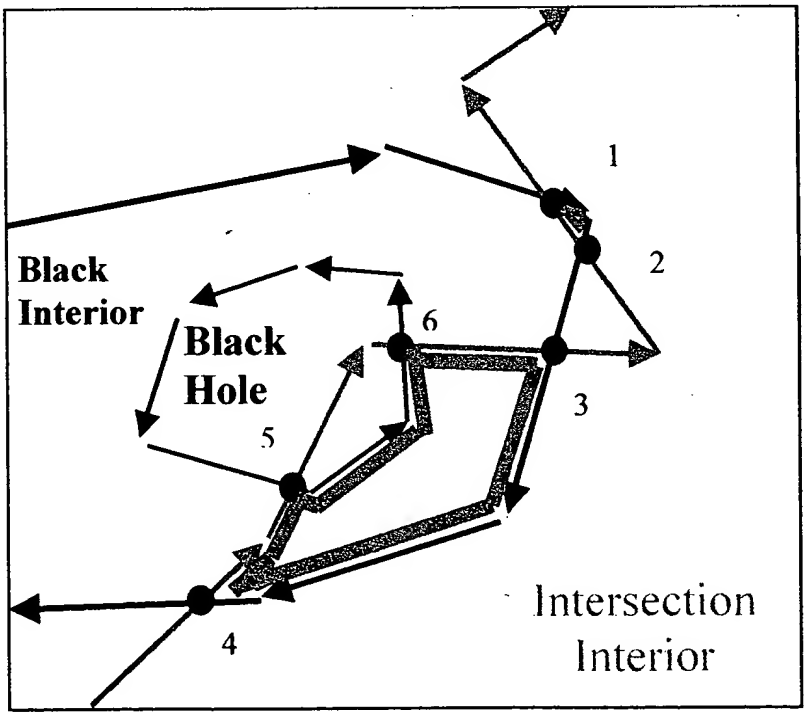


Fig. 26

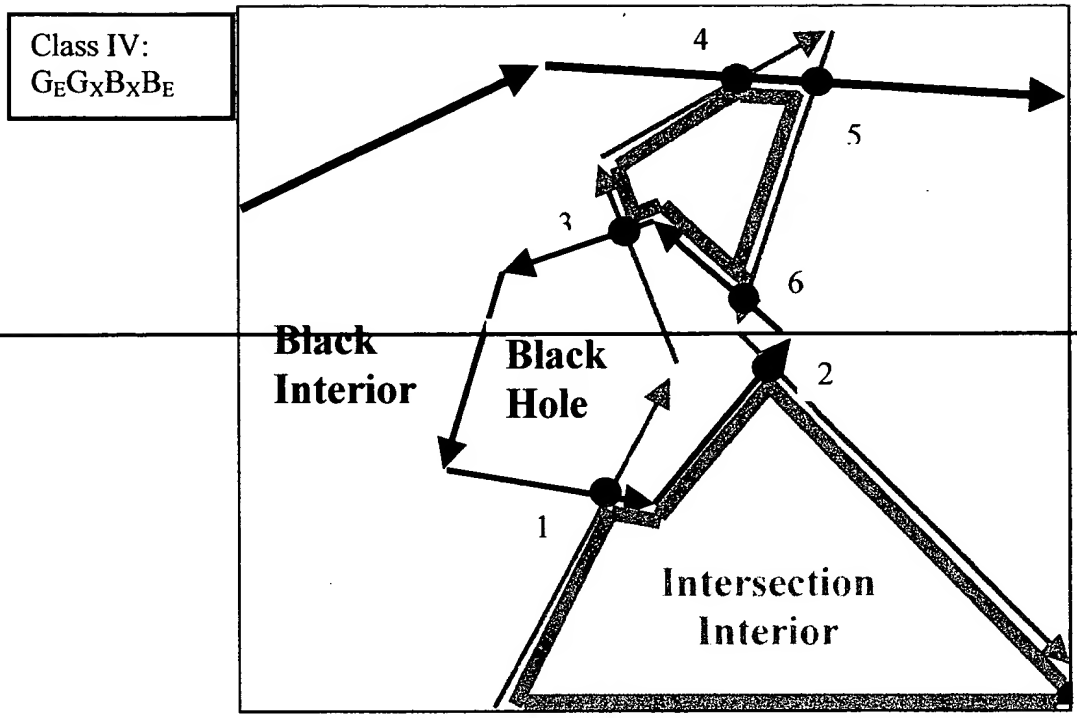

Class IV:
$G_E G_X B_X B_E$
4
5
3
6
Black
Interior
Black
Hole
2
1
Intersection
Interior

Fig.27

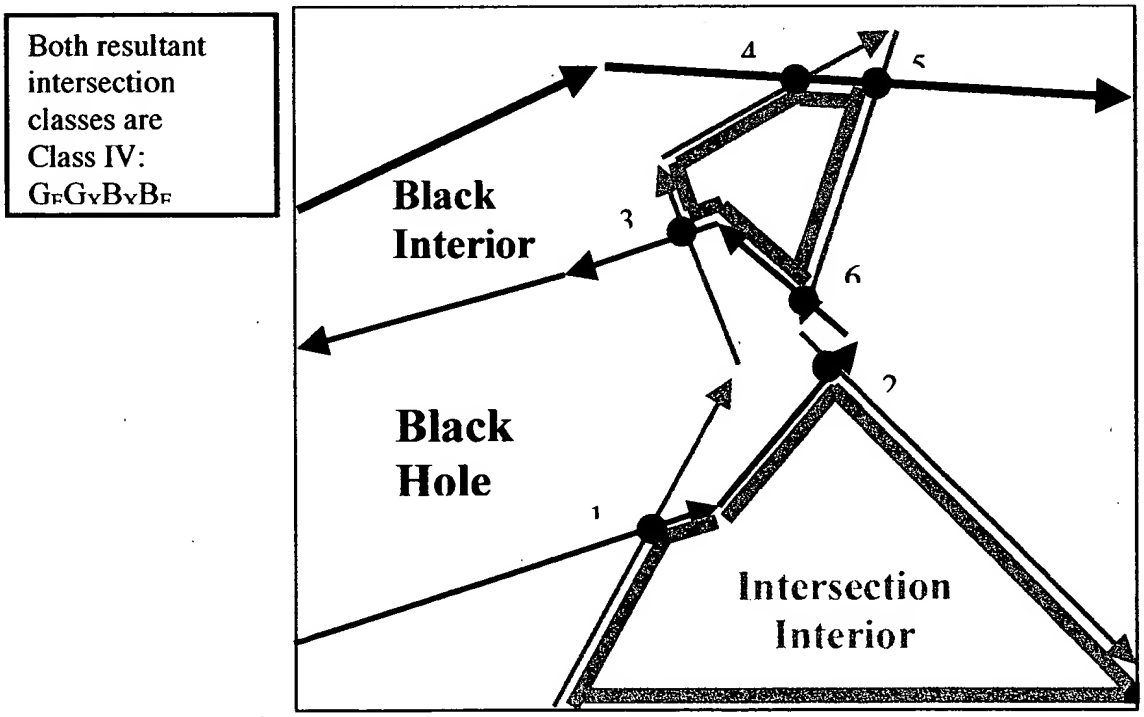

Both resultant
intersection
classes are
Class IV:
$G_E G_V B_V B_E$
4
5
Black
Interior
3
6
Black
Hole
2
1
Intersection
Interior

Fig. 28

Entry/Exit Relationship	Class	Total # of Intersecti tuples within cell	Entry/exit relationship adjacent/ alternating	Special cases # Intersect points	Total Intersect Cycles (to the right)	Total # of NOT union cycles (to the right)	Total Intersect cycles (to the left)	Total # of NOT union cycles (to the left)
$G_EG_XB_EB_X$	I	even	adjacent	0 2	0 1	2 2	1 1	full cell 2
$G_EB_XB_EG_X$	II	even	adjacent	0 2	1 2	full cell 1	0 2	2 1
$G_EB_EB_XG_X$	III	even	adjacent	0 2	1 1	1 1	1 1	1 1
$G_EB_EG_XB_X$	VI	odd	alternating	1	1	1	1	1
$G_EG_XB_XB_E$	IV	even	adjacent	0 2	1 1	1 1	1 1	1 1
$G_EB_XG_XB_E$	V	odd	alternating	1	1	1	1	1

Fig. 29

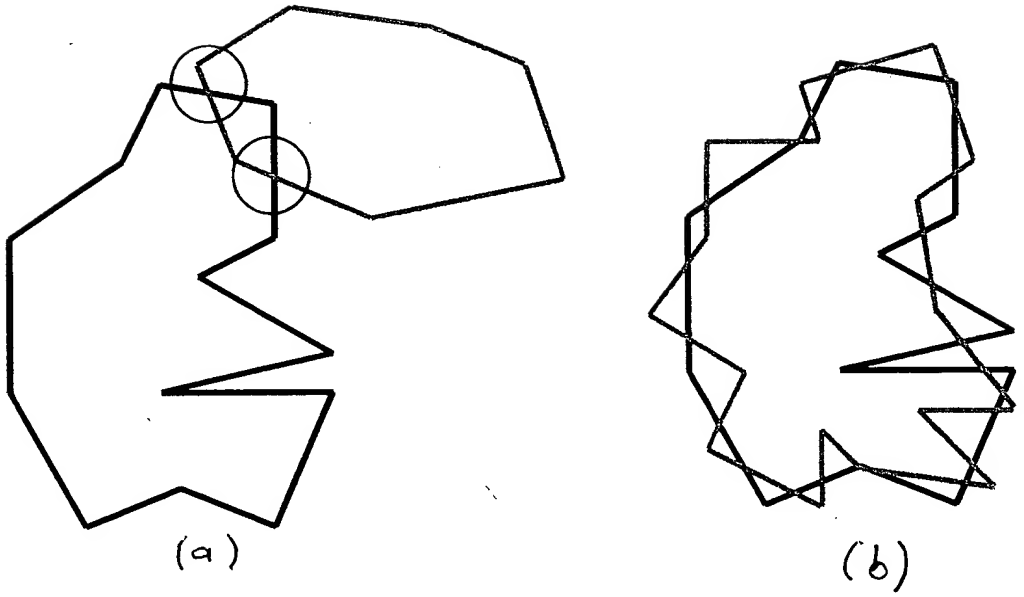


Fig. 30